DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

Agency for Toxic Substances
and Disease Registry
Atlanta GA 30333

January 31, 2002

Mr. Jon W. Peterson
SR-6J
U.S. Environmental Protection Agency, Region V
77 West Jackson Boulevard
Chicago, IL 60604-3507

Dear Mr. Peterson:

Enclosed please find a copy of the health consultation for the Four County Landfill, Rochester, Fulton County, Indiana, EPA FACILITY ID: IND000780544, dated January 25, 2002. This health consultation is in response to the Indiana State Department of Health's request that the Agency for Toxic Substances and Disease Registry review the residential use of potentially contaminated groundwater near the Four County Landfill in Fulton County, Indiana.

Please address correspondence to the Chief, Program Evaluation, Records, and Information Services Branch, Division of Health Assessment and Consultation, Agency for Toxic Substances and Disease Registry, ATTN: Four County Landfill, 1600 Clifton Road, NE (E56), Atlanta, Georgia 30333.

If there are any questions, please direct them to Brian Kaplan, health assessor, at (404) 639-0503.

Sincerely yours,

Max M. Howie, Jr.
Chief, Program Evaluation, Records,
and Information Services Branch
Division of Health Assessment
and Consultation

Enclosure

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Health Consultation

Offsite Groundwater Contamination

FOUR COUNTY LANDFILL

ROCHESTER, FULTON COUNTY, INDIANA

EPA FACILITY ID: IND000780544

JANUARY 25, 2002

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

Health Consultation: A Note of Explanation

An ATSDR health consultation is a verbal or written response from ATSDR to a specific request for information about health risks related to a specific site, a chemical release, or the presence of hazardous material. In order to prevent or mitigate exposures, a consultation may lead to specific actions, such as restricting use of or replacing water supplies; intensifying environmental sampling; restricting site access; or removing the contaminated material.

In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

Offsite Groundwater Contamination

FOUR COUNTY LANDFILL

ROCHESTER, FULTON COUNTY, INDIANA

EPA FACILITY ID: IND000780544

Prepared by:

Exposure Investigation and Consultation Branch
Division of Health Assessment and Consultation
Agency for Toxic Substances and Disease Registry

BACKGROUND AND STATEMENT OF ISSUES

The Indiana State Department of Health requested assistance from the Agency for Toxic Substances and Disease Registry (ATSDR) to review the residential use of potentially contaminated groundwater near the Four County Landfill in Fulton County, Indiana. The landfill operated from 1972 to 1989 on 61 acres, 0.7 miles southwest of Delong, Indiana. The landfill accepted municipal, industrial, and hazardous wastes. A church and a cottage are located across the street near the northwest corner of the landfill. Several trailer homes and a forested wetland area are north of the landfill.

Private wells near the landfill may be impacted by groundwater contamination. The contamination consists predominately of 1,2-dichloroethane (DCA) with maximum offsite concentrations reaching 1,400 µg/L. The closest groundwater use includes the church and cottage, mentioned above, with private wells adjacent to the northwest corner of the landfill [1]. As part of the State investigation and cleanup, Indiana Department of Environmental Management (IDEM) divided the landfill into two Operable Units (OU1 and OU2). OU1 consists of onsite soil and groundwater contamination, offsite contaminated soils, and perched groundwater located adjacent to the western and northern boundary of the landfill. OU1 remediation includes a landfill cap, leachate collection and treatment system, landfill gas collection and treatment, groundwater monitoring, deed groundwater use restrictions, and access controls of the landfill property. The OU1 remedy was constructed in 1999 and maintenance and monitoring of the systems continue.

OU2 consists of offsite groundwater contamination excluding the perched groundwater investigated in OU1. The OU2 investigation determined the nature and extent of the offsite groundwater contamination. The offsite groundwater contamination was investigated in part, through:

- Installation and sampling of thirty-one offsite monitoring wells. Fifteen of these wells were installed in the water-table aquifer near the vadoze zone-water table interface and sixteen wells were installed in the highly permeable coarse sand and gravel zones of the glacio-fluvial aquifer (the major source of groundwater for domestic, livestock, industrial, and public supplies in Fulton County [2]). The water-table aquifer is separated from the glacio-fluvial aquifer by a discontinuous layer of silt.

- Sampling and analysis of residential wells.

On July 16, 2001, IDEM signed the Record of Decision (ROD) for Remedial Action for OU2. The remedial action selected for the site was Monitored Natural Attenuation. The remedy consists of the following:

- Installing a performance monitoring, assessment, and sentry monitoring well network.

- Preparing an alternative remedial action plan, and implementing the plan, if the natural attenuation remedy is not working.

- Groundwater monitoring of residential and monitoring wells impacted by the contaminated plume.

- Installing filters at the point of use in residences that are in the area of concern and that show site related contaminants in their drinking water.

- Imposing deed restrictions and groundwater use restrictions to advise future owners of groundwater contamination and restrict current use of the groundwater [3].

ATSDR reviewed the groundwater sampling data from the offsite monitoring wells and residential wells collected during the OU2 investigation. The data are summarized below followed by a discussion of health implications and recommendations for reducing exposure.

In 1990, ATSDR completed a petitioned Public Health Assessment (PHA) of the landfill [4]. The PHA concluded that off-site groundwater was a health concern and recommended additional monitoring. This Health Consultation includes data from this monitoring and other data that was obtained since 1990.

In summary, ATSDR reviewed the data and found that the past uses of the private wells are not a public health hazard. The Indiana Department of Environmental Management (IDEM), through the State Cleanup Site program, is monitoring current and future use of the wells in the vicinity of the groundwater contamination emanating from the Four County Landfill. Natural levels of arsenic in several groundwater wells are above levels of concern. Residents should be educated about arsenic and the methods they may use to reduce the levels in the drinking water.

Monitoring Wells

Data has been collected from monitoring wells since 1996 (See Appendix A for a summary of sampling dates and chemicals analyzed). Significant groundwater impacts (exceeds an EPA maximum contaminant level [MCL] or ATSDR comparison value) from organic chemicals occur in one shallow monitoring well (MW113) adjacent to the landfill and three monitoring wells (MW112, MW114, and MW124) in the deeper portion of the aquifer. The organic compound results are shown in Table 1 for those wells with analytes exceeding an MCL or ATSDR screening value.

Table 1. Monitoring Wells with Organic Analytes Exceeding an MCL or ATSDR Screening Value [5].

Analyte	Concentration Range (µg/L)				MCL/Screening Value (µg/L)
	Water Table Aquifer	Deeper Aquifer			
	MW113	MW112	MW114	MW124	
Benzene	ND to 3.4J	ND	240 to 460	ND	5 (MCL)
Chloroform	57J to 66	ND	ND	ND	6 (CREG)
Carbon tetrachloride	45J to 140	ND	ND	ND	5 (MCL)
1,2-Dichloroethane	ND to 4.4J	ND to 85	780 to 2000	63 to 1,400	5 (MCL)
Vinyl chloride	ND	ND to 0.65 (estimated)	ND to 5.2 (estimated)	ND to 8.7	2 (MCL)

µg/L - microgram of contaminant per liter of water
ND - Not detected
J - Estimated
CREG - An ATSDR Cancer Risk Evaluation Guide for $1x10^{-6}$ excess cancer risk
MCL - U.S. EPA maximum contaminant level for drinking water

Wells MW112 and MW114 are next to the north landfill boundary. They were screened in glacio-fluvial outwash of sands and gravels at 110 (MW112) and 128 (MW114) feet below ground. Well MW124 is approximately 700 to 800 feet north to northeast of MW112 and MW114 and is screened at 124 feet below the ground surface in the same stratigraphic unit as MW112 and MW114. Well MW113 is screened at 60 to 70 feet below the ground surface adjacent to the northern edge of the landfill and next to MW114. While MW113 and MW114 are located adjacent to each other and screened in stratigraphic units that are different but hydraulically connected, the concentrations detected in each well are very different.

The wells (including MW112, MW114 and MW124) indicate that a 400-foot wide 1,2-DCA plume extends about 1/4 mile down-gradient of the site and is located in the deeper portion of the aquifer. Wells located in the shallow groundwater near Well 124 have shown only trace levels of contaminants (<2.5 µg/L of 1,2-DCA and carbon tetrachloride)

Metals detected above screening values in the shallow and deep groundwater monitoring wells included antimony, aluminum, iron, and manganese. Antimony was detected in shallow well MW116 at 42 µg/L (MCL = 6 µg/L) and deep well MW109 at 35 µg/L. This sample was unfiltered. Filtered samples of the same water from both wells had antimony concentrations below 0.03 µg/L. Antimony was not detected in any other monitoring wells and MW116 is hydraulically cross-gradient from the landfill.

Aluminum was detected above EPA's SMCL of 200 µg/L in three shallow groundwater wells MW119, MW121, and MW125 in 1997. Samples collected from these wells in 1999 showed aluminum below the SMCL. The maximum measured concentration of aluminum was 1.7 mg/L.

Iron and manganese were detected above the SMCLs in multiple shallow and deep monitoring wells. Iron and manganese are often naturally occurring and in this case, were demonstrated to be present in elevated concentrations in upgradient groundwater [3]. In the shallow and deep offsite groundwater monitoring wells, the maximum concentrations of iron (26 mg/L) and manganese (0.54 mg/L) were detected above their SMCLs of 0.3 mg/L and 0.05 mg/L, respectively.

The groundwater flow direction is north/northeast toward the Tippecanoe River approximately 3/4-miles downgradient. The Tippecanoe River appears to be the discharge point for the ground water [5].

Residential Wells

ATSDR reviewed residential well data from the Fulton County Hazardous Substance Committee (FCHSC) and IDEM. The data indicated that 45 residential water wells are within 1.5 miles of the landfill. The FCHSC sampled 33 of these drinking water wells periodically from 1988 to 1995 for volatile organics, semivolatile organics, metals, nitrates, chloride, and radionuclides (See Appendix B for a summary of the data). The sampling frequency varied from a one-time sampling to up to 18 times for one well (resampling every 2 to 8 months). Of these 33 wells, 10 wells are within 0.25 miles of the site (Wells RW-8, RW-11, RW-14, RW-12, RW-15, RW-17, RW-18, RW-24, RW-25, RW-33). Well RW-37, installed in January 1995, is within 0.25 miles of the site but ATSDR does not have data for this well. There are four wells located hydraulically downgradient in or adjacent to the 1,2-dichloroethane groundwater plume (the plume edge is defined by the MCL of 5 µg/L). These wells are screened at 62, 68, 78, and 122 feet below the ground surface. The well screened at 122 feet is located adjacent and lateral (west) of the plume edge (groundwater flow is to the north/northeast). The off-site groundwater plume is generally limited to the lower portion of the glacio-fluvial aquifer in the region at depths greater than 100 feet [5].

Well water monitoring has not identified any site-related contaminants above concentrations of concern in any residential wells located near the site [5]. Two wells, RW-19 and RW-20 were the only wells with organic chemicals detected in the groundwater samples. RW-19 is located 1.5 miles north/northwest of the site and adjacent to the Tippecanoe River. RW-19 was sampled by the FCHSC at least six times beginning September 20, 1988 through November 18, 1991. These samples were analyzed for 1,2-dichloroethane five times [5, 6, 7]. The sample collected July 16, 1991 contained 1,2-dichloroethane at 1.9 µg/L. A subsequent sample collected November 18, 1991 did not detect 1,2-dichloroethane. The other four samples found 1,2-dichloroethane below detection levels of 1 µg/L. Based on the site hydrology described in the Remedial Investigation Report [5], it is unlikely that the contamination in this well is from the Four County Landfill.

The second well with detected organic contamination is RW-20. RW-20 is located just north of the landfill, across road W 525 North and is 69 feet deep. RW-20 was sampled 11 times from September 30, 1988 to September 1994. 1,2-dichloroethane was detected five times with the maximum detection of 0.6 µg/L in July 1991. 1,2-dichloroethane has not been detected in five sampling events since July 1991. Methylene chloride was detected once in Sept 1994 at 1.2 µg/L (MCL = 5.0 µg/L).

Iron (maximum detected was 8560 mg/L) and manganese (maximum detected at 0.35 mg/L) in the residential wells exceeded SMCLs of 0.3 mg/L and 0.05 mg/L, respectively (See Table 2). The value of 8560 mg/L iron was detected in residential well RW-20 on May 1, 1990. In subsequent samples, iron ranged from 2.2 to 9.9 mg/L. Another well (RW-33) had iron concentrations of 2460 mg/L and 2430 mg/L in Sept 1989 and May 1990, respectively and no samples were collected since May 1990. A third well had iron values of 3170 mg/L (RW-12) on May 1, 1990. A duplicate sample collected the same day from this well measured iron at 3110 mg/L. Subsequent samples from this well indicated that iron ranged from 3.0 to 6.2 mg/L. A fourth well (RW-25) had iron concentrations ranging form 3.3 to 3,900 mg/L. In this well 3,810 and 3,900 mg/L iron were detected in September 1989 and May 1990, respectively. In subsequent samples, iron ranged from 3.3 to 8.1 mg/L. Iron concentrations above 1 mg/L and below 10 mg/L were commonly detected in the monitoring wells.

Table 2. Residential Wells with Metals Exceeding an MCL or ATSDR Screening Value [5].

Analyte	Concentration Range (µg/L)	MCL/Screening Value (µg/L)
Arsenic	(wells above 10 µg/L) RW-15 9 to 14 RW-18 5 to 24 RW-23 11.5 to 43* RW-26 5 to 48** RW-32 7.7 to 20*	10 (MCL-promulgated October 31, 2001 and effective January 2006)
Iron	RW-12 3,300 to 3,170,000 RW-20 2,200 to 8,560,000 RW-25 3,300 to 3,900,000 RW-33 2,430,000 to 2,460,000	300 (SMCL)
Nickel	RW-25 <0.1 to 110	100 (MCL)
Manganese	RW-3 350*** RW-7 260*** RW-8 90*** RW-11 100*** RW-12 74 to 110 RW-13 120*** RW-14 70*** RW-20 110 to 200 RW-25 90 to 140 RW-26 60*** RW-29 70*** RW-31 190*** RW-32 50*** RW-33 40 to 50	50 (SMCL)/500 RMEG

* The high value in the range was in the last sampled collected in May 1995.

** 48 mg/L was detected in March 1988. Six samples after March 1988 were below 10 mg/L.

*** Wells may have been sampled one time or multiple times but were analyzed for manganese only one time.

µg/L - microgram of contaminant per liter of water.

MCL - U.S. EPA maximum contaminant level for drinking water.

RMEG - ATSDR's media evaluation guide based on EPA's reference dose.

SMCL - U.S. EPA secondary maximum contaminant level for drinking water.

Manganese was detected above the SMCL (50 mg/L) in 14 wells while all samples were below the ATSDR's health-based value of 500 mg/L.

Nickel was detected in well RW-25 at 110 µg/L in 1989. An MCL doesn't exist for nickel. However, EPA's lifetime health advisory is 100 µg/L. Subsequent to this sample, the nickel concentrations ranged from not detected (less than 0.5 µg/L) to 12 µg/L.

Arsenic values in the residential wells ranged from not detected (less than 5 µg/L) to 48 µg/L. The recently promulgated MCL for arsenic is 10 µg/L (promulgated October 31, 2001 and effective January 2006).

In March 1998, IDEM sampled 13 residential wells that were within two miles of the landfill (See Appendix C). These samples were analyzed for 60 volatile and semivolatile organic compounds and 30 metals. Organic compounds detected included trichloromethane (detected in two wells with a 2.3 µg/L maximum) and 1,4-dichlorobenzene (detected in one well with a value of 0.9 µg/L).

With respect to metals, arsenic levels exceeded the newly promulgated arsenic MCL of 10 µg/L in two wells. Arsenic levels ranged from not detected (less than 4.0 µg/L) to 21 µg/L.

In the most recent round of off-site sampling conducted on August 4, 1999, IDEM collected nine water samples from residential wells and one water sample from an irrigation well near the site. Samples were analyzed for VOCs. Toluene was the only VOC detected in the well water samples, with concentrations ranging from 17 µg/L to 30 µg/L [8]. Toluene was detected in the irrigation well sample at 30 µg/L. Toluene was not detected in the trip blanks. Previous detections of toluene in the monitoring wells included an estimated value near the detection limit in one sample at 1 µg/L in 1997 and another sample at 1.1 µg/L in May 1999.

DISCUSSION

Groundwater monitoring demonstrated that the chemical contaminants in the off-site plume are limited to the lower portion of the glacio-fluvial aquifer in the region at depths greater than 100 feet [5]. Several organic compounds and metals were detected in a few residential wells in the shallower portion of the aquifer. The organic compounds included 1,2-dichloroethane, 1,4-dichlorobenzene, methylene chloride, bromodichloromethane, dibromochloromethane, trichlorofloromethane, and toluene (the detection of toluene was most likely caused by laboratory contamination). These compounds were found in levels below health-based levels of concern. Organic compounds found in the monitoring wells above levels of concern included benzene, chloroform, carbon tetrachloride, 1,2-dichloroethane, and vinyl chloride.

The metals of concern that were detected in the residential wells include arsenic and iron. Arsenic was detected at levels ranging from not detected (less than 5 µg/L) to 48 µg/L. ATSDR is concerned about arsenic because five residential wells sampled by FCHSC and two wells

sampled by IDEM exceeded the newly promulgated arsenic MCL of 10 µg/L [9]. Based on the regulations, the MCL applies to community water systems and nontransient, noncommunity water systems[1] and does not apply to private wells. However, ATSDR is using the MCL here for private wells because the potential for increased health risks, when arsenic is above 10 µg/L, still exists.

Arsenic is a naturally occurring element in groundwater. Arsenic can also come from industrial sources. In this case, the arsenic is naturally occurring and not the result of activities at the Four County Landfill. The arsenic level in the monitoring wells ranged from 5 µg/L to 11 µg/L.

Iron was detected at very high values in four residential wells, one well had iron concentrations of 8,560 mg/L. Iron exceeded the secondary maximum contaminant level of 0.3 mg/L. The SMCLs are non-enforceable guidelines regulating contaminants that may cause cosmetic effects (such as skin or tooth discoloration) or aesthetic effects (such as taste, odor, or color) in drinking water. Iron adds a metallic taste to the water and colors the water red to brown. Subsequent sampling of three of the four residential wells indicated that iron concentrations dropped to below 10 mg/L. A fourth well that was not resampled had iron levels of approximately 2,400 mg/L. The highest iron concentration found in any monitoring well was 26 mg/L.

ATSDR does not have a health-based comparison value for iron. As an alternative, ATSDR compared the iron concentrations to EPA Region 3's health risk-based concentrations (RBCs). Risk-based concentrations are based on 30 years of exposure, 350 days per year. The RBC for iron is 11.0 mg/L. The highest levels detected were 200 times or more above the RBC.

Iron is a necessary element in our diet. In the human body, iron is present in all cells and has several vital functions – as a carrier of oxygen to the tissues from the lungs in the form of hemoglobin (Hb), as a facilitator of oxygen use and storage in the muscles as myoglobin, as a transport medium for electrons within the cells in the form of cytochromes, and as an integral part of enzyme reactions in various tissues. Too little iron can interfere with these vital functions. Iron greater than 11.0 mg/L, would also be a concern.

Iron is a natural element in the earth. It is always found combined with other elements that compose the clays and minerals that make up the rocks and soils of the earth. Iron makes up about 5 percent of the surface of the earth and is present in many food items. Iron levels above 1 mg/L and below 10 mg/L in groundwater are common in the Ohio River Basin which includes the Four County Landfill [10].

Iron is a major component of galvanized pipe that was the predominant pipe used in residential plumbing. Sometimes, through inactivity, water in the pipe will accumulate iron from the pipes.

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[1] **Community Water Systems** are public water systems that supply water to the same population year-round. **Non-Transient Non-Community Water Systems** are public water systems that regularly supply water to at least 25 of the same people at least six months per year, but not year-round. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.

Then, when the water is turned on, the water appears red to brown until the "old" water is flushed out.

Iron in the water may be from corroding water pipes or from the groundwater itself. From the monitoring well data, the highest reported iron level in the shallow offsite wells was 26 mg/L and 4.4 mg/L in the deep offsite wells. Although ATSDR does not know for certain, the lower groundwater iron levels in the monitoring wells indicate that the high iron levels may have come from the residential plumbing. This would especially be true if the water samples were collected on first draw from a faucet inside the homes without flushing the water lines. However, ATSDR does not know the procedures followed during the sampling or the materials of the plumbing. Nonetheless, ATSDR concludes that iron is not an apparent public health hazard because (1) four wells showed very high levels of iron (100 times greater than background), (2) the iron levels in three of these four wells dropped to background levels on subsequent sampling, (3) the fourth well was not subsequently resampled, and (4) the high iron levels could be from the plumbing which would indicate that the iron levels would drop significantly if the plumbing system was used regularly.

Manganese was detected above the SMCL (50 µg/L) in 14 wells with all samples below the ATSDR's health-based value of 500 µg/L. Manganese has an SMCL because of the aesthetic effects of black staining, bitter metallic taste, and black to brown discoloration of the water. Since the manganese concentrations are below ATSDR's health-based value, the levels of manganese detected in the residential wells are not a health hazard.

Samples collected by the FCHSC found 1,2-dichloroethane in two off-site residential wells RW-19 and RW-20. RW-19 is not a health concern because it is unlikely that the well is impacted by the landfill because of the groundwater hydrology and 1,2-dichloroethane was detected only once, below MCLs, and a subsequent sample did not detect it.

The use of water from RW-20 is not an apparent health hazard because the chemicals detected in the well were below MCLs. However, the proximity to the landfill is a concern for possible future exposure. IDEM will be monitoring this well as discussed below.

Toluene was the only VOC detected in the samples collected on August 4, 1999 from the off-site residential and irrigation wells. The MCL for toluene is 1 mg/L (1000 µg/L). The concentrations reported, 7 to 30 µg/L, are 30 times below the MCL. Therefore, exposure to this level of toluene is not considered a threat to human health. IDEM attributed the detection of toluene to laboratory contamination [5].

There is limited potential for future residential development north of the landfill since an extensive wetland is present [5]. However, if wells are installed in this area, the wells should be sampled for site-related contaminants. Although there is a natural "nonexistent or negligible" vertical gradient [5], residential wells that are located over an area of deeper groundwater contamination have the potential to draw the contamination to them. In addition, wells located

adjacent to the plume edge have the potential to draw contamination to them. Therefore, existing wells above or adjacent to the groundwater plume should be monitored.

ONGOING ACTIVITIES

Based on the Record of Decision for Operable Unit 2 (ROD), IDEM is implementing the following actions to protect public health:

- Monitoring area residential wells for contamination;
- Restricting groundwater use with Restrictive Covenants and/or install filters on the residential water systems if the residential wells become contaminated;
- Imposing deed restrictions to advise future owners of groundwater contamination; and,
- Monitoring the groundwater plume to ensure cleanup.

The ROD specifies that residential wells in proximity of the plume are to be monitored but doesn't specifically state which wells, how often, or which contaminants will be analyzed for. The ROD also states that deed restrictions will be imposed but doesn't specify the spatial or temporal extent of the restrictions. ATSDR recommends that the specifics of the well monitoring and deed restrictions be provided in the Remedial Design and Remedial Action work following the ROD. The spatial extent of the monitoring and deed restrictions should be based, in part, on the hydrology of the aquifer and the time-of-travel capture zones of the wells.

A home located above the plume on Prairie Road north of the landfill was recently purchased after being unoccupied for an unknown amount of time. The home and well are not currently being used but there are plans to occupy the dwelling. The Responsible Parties sampled the well and the water is above MCLs. The Responsible Parties will be installing a water treatment system at the home in the spring of 2002. The new owners plan to occupy the home at that time. IDEM is requiring the Responsible Parties to sample the well every three months pre- and post-filter [11].

CONCLUSIONS

1. Although groundwater contamination (1,2-DCA) has migrated 1/4 mile off-site, residential well water sampled near the Four County Landfill site was not contaminated with VOCs at levels that posed a threat to human health.

2. New and existing wells located above or lateral to the organic contaminant plume may be adversely impacted by contamination in the future.

3. The levels of arsenic in several residential water samples exceeded the newly promulgated arsenic MCL (promulgated October 31, 2001 and effective January 2006). Arsenic appears to be naturally occurring in the groundwater.

4. Iron is elevated in four residential water wells, the levels were not consistently high in three of the four wells, and presumably the iron comes from the plumbing system.

RECOMMENDATIONS

1. IDEM is implementing the Record of Decision's cleanup alternative to protect current and future use of the groundwater. ATSDR recommends that IDEM include specifics of the well monitoring and deed restrictions in the Remedial Design and Remedial Action work following the ROD. These specifics should include the spatial extent of the monitoring and deed restrictions based in part on the hydrology of the aquifer and the time-of-travel capture zones of the wells.

2. ATSDR recommends that the Indiana State Department of Health educate area residents about arsenic and iron in the groundwater and methods they may use to reduce the levels.

REFERENCES

1. ATSDR's Agency Record of Activity (AROA) conference telephone call between Robert L. Williams (ATSDR) and Vince Epps, project manager for Indiana Department Environmental Management, August 23, 2000.

2. Rosenshein, S.S., and J.D. Hunn, Groundwater Resources of Northwestern Indiana, Preliminary Report: Fulton County. U.S. Geological Survey, Water Resources Bulletin No. 20, 1964 in IDEM Four County Landfill Operable Unit 2 Remedial Investigation Report, July 1999.

3. IDEM, Record of Decision Summary, Four County Landfill, Operable Unit Two, July 16, 2001.

4. Agency for Toxic Substances and Disease Registry. Petitioned Public Health Assessment of Four County Landfill, Fulton County, Indiana. Atlanta, US Department of Health and Human Services; July 25, 1990.

5. IDEM Four County Landfill Operable Unit 2 Remedial Investigation Report, January 2000.

6. Environmental Health Laboratories. Laboratory report for Fulton County Hazardous Substance Committee for samples collected and received 11-18-91.

7. ATSDR's Agency Record of Activity (AROA) conference telephone call between Brian Kaplan (ATSDR) and Wesley Burden, Fulton County Health Department, January 9, 2002.

8. IDEM, Memorandum, Four County Landfill Site Sampling Results, September 1999.

9. U.S. EPA Fact Sheet, "EPA To Implement 10ppb Standard for Arsenic in Drinking Water," EPA 815-F-01-010, October 2001. http://www.epa.gov/safewater/ars/ars-oct-factsheet.html [accessed November 23, 2001].

10. Eberts, Sandra M. and Lori L. George. Regional Ground-Water Flow and Geochemistry in the Midwestern Basins and Arches Aquifer system in Parts of Indiana, Ohio, Michigan, and Illinois. U.S. Geological Survey Professional Paper 1423-C, no date. Accessed from http://water.usgs.gov/pubs/pp/pp1423-c/

11. ATSDR's Agency Record of Activity (AROA) conference telephone call between Brian Kaplan (ATSDR) and Pat Liken, Indiana Department Environmental Management, January 16, 2002.

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Appendix A. Off-site monitoring wells, sampling dates, and constituents analyzed for [5].

Sampling Date	Wells	Constituents Analyzed For
September 1996	MW100 through MW118	VOCs, SVOCs, metals, radionuclides, and general chemistry parameters.*
November 1997	MW101, 102, 106, 107, 110, 111, 112, 113, 114, 117, 118,	VOCs and general chemistry parameters.*
November 1997	MW119 through 126	VOCs, SVOCs, metals, and general chemistry parameters.**
March 1998	MW111 through MW114, MW123, and MW124.	VOCs
September 1998	MW124	VOCs
April and May 1999	MW100 through MW130	VOCs, 6 metals and general chemistry parameters.***

*Alkalinity, ammonia, chloride, cyanide, iron (ferrous), nitrate, pH, sulfate, total dissolved solids, total suspended solids.

**Alkalinity, chloride, dissolved and total organic carbon, dissolved gases (ethane, ethene, methane), iron (total), nitrate, pH, sulfate, sulfide, total dissolved and suspended solids.

***Alkalinity, chloride, dissolved organic carbon, dissolved gases (ethane, ethene, methane), iron (total), nitrate, nitrite, pH, sulfate, sulfide, total dissolved and suspended solids. Metals included aluminum, calcium, copper, manganese, magnesium, and sodium.

Appendix B. Summary of Residential Sampling Results. Samples were collected and analyzed by the Fulton County Hazardous Substance Committee (FCHSC) [5, 6] .

Well	Sampling Begin	Sampling End	Number of Samples	Comments*
RW-1	11/18/91	11/30/92	3	
RW-2	03/28/91	07/05/95	14	
RW-3	09/08/94	05/11/95	2	5/11/95. Manganese at 350 µg/L. The SMCL is 50 µg/L is set for aesthetic reasons because of taste, color, and staining. Specifically black to brown color; black staining; and bitter metallic taste. For health issues, the ATSDR lowest health-based comparison value for manganese is 500 µg/L.
RW-4	04/23/93	04/23/93	1	
RW-5	11/18/91	05/11/95	8	
RW-6	09/30/88	05/11/95	13	
RW-7	9/30/88	11/18/91	6	Arsenic ranged from not detect (<0.5 µg/L) to 6.1 µg/L and was detected three times. Of the three detections, arsenic was measured above 5 µg/L twice three years apart. The third detection was measured at 1.6 µg/L.
RW-8**	**09/30/88**	**11/18/91**	**6**	7/16/91. Manganese at 90 µg/L.
RW-9	05/18/89	09/25/89	2	
RW-10	11/18/91	11/18/91	1	
RW-11	**09/30/88**	**07/16/91**	**6**	7/16/91. Manganese at 100 µg/L

Appendix B. Summary of Residential Sampling Results. Samples were collected and analyzed by the Fulton County Hazardous Substance Committee (FCHSC) (Continued).

Well	Sampling Begin	Sampling End	Number of Samples	Comments*
*RW-12****	*05/01/90*	*07/05/95*	*16*	Manganese concentrations varied from 74 to 100 µg/L. Iron concentrations measured at 3170 mg/l and in a duplicate sample at 3110 mg/L on 5/1/90. Subsequent iron values ranged from up to 3.0 to 6.2 mg/L. Iron's SMCL of 0.3 mg/L is set for aesthetic reasons for taste, color, and staining. Specifically, rusty color; sediment; metallic taste; and reddish or orange staining. ATSDR does not have a health-based comparison value for iron. As an alternative, ATSDR compared the iron concentrations to EPA Region 3's health risk-based concentrations (RBCs). Risk-based concentrations are based on 30 years of exposure, 350 days per year. The RBC for iron is 11.0 mg/L.
RW-13	07/16/91	05/11/95	9	7/16/91. Manganese at 120 µg/L.
RW-14	**09/30/88**	**11/18/91**	**6+1 dup**	7/16/91. Manganese at 70 µg/L.
RW-15	*09/30/88*	*05/18/89*	*2*	Arsenic values ranged from 9 to 14 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-16	09/30/88	05/18/89	2	
RW-17	**09/03/93**	**09/03/93**	**1**	
RW-18	*09/30/88*	*05/11/95*	*9+1 dup*	Arsenic values ranged from not detected (<12.7 µg/L) to detected values ranging from 5 µg/L to 24 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-19	09/30/88	11/18/91	6	1,2-DCA was detected once on 16 July 1991 at 1.9 µg/L (MCL is 5 µg/L). A subsequent sample did not detect 1,2-DCA. This well is located about 1.5 miles north/northeast of the site adjacent to the Tippecanoe River. Based on the reported hydrology of the site and reported shape and location of the groundwater plume, it is unlikely that RW-19 could have been the source of 1,2-DCA.

Appendix B. Summary of Residential Sampling Results. Samples were collected and analyzed by the Fulton County Hazardous Substance Committee (FCHSC) (Continued).

Well	Sampling Begin	Sampling End	Number of Samples	Comments*
RW-20	**09/30/88**	**07/05/95**	**17**	RW-20 is located adjacent to the site. 1,2-DCA was detected on the following dates. The MCL is 5.0 µg/L Date — Concentration (µg/L) 09/30/88 — 0.35 05/18/89 — 0.27 09/25/89 — 0.27 05/1/90 — 0.28 03/28/91 — ND (0.5) 07/16/91 — 0.6 11/18/91 — ND (0.5) 04/29/92 — ND (0.5) 11/30/92 — ND (0.5) 04/23/93 — ND (0.5) Methylene chloride was detected once on 09/8/94 at 1.2 µg/L. The MCL is 5.0 µg/L. Manganese concentrations ranged from 110 to 200 µg/L. Iron concentrations were measures as high as 8560 mg/L on 5/1/90. The previous sample on 9/25/89 measured 3250 mg/L. In subsequent samples, the iron values ranged from 2.2 to 9.9 mg/L.
RW-21	09/03/93	09/03/93	1	
RW-23	09/30/88	05/11/95	11	Arsenic values ranged from 11.5 to 43 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-24	**09/30/88**	**09/30/88**	**1**	The one sample contained arsenic at 8 µg/L.

Appendix B. Summary of Residential Sampling Results. Samples were collected and analyzed by the Fulton County Hazardous Substance Committee (FCHSC) (Continued).

Well	Sampling Begin	Sampling End	Number of Samples	Comments*
RW-25	**09/30/88**	**07/05/95**	**18**	Manganese concentrations ranged from 60 to 140 µg/L. Iron was not sampled for prior to 9/25/89. On 9/25/89, iron was measured at 3810 mg/L and the subsequent sample on 5/1/90, iron was measured at 3900 mg/L. In subsequent samples, iron concentrations ranged from 3.3 to 8.7 mg/L. Nickel was measured at 110 µg/L on 9/25/89. There is not an MCL for nickel. The EPA lifetime health advisory level is 100 µg/L. Subsequent to this sample, the nickel concentrations ranged from not detected (0.5 µg/L) to 12 µg/L.
RW-26	09/30/88	11/18/91	6	Arsenic values ranged from 5 to 48 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-27	07/05/95	07/05/95	1	The one sample contained arsenic at 5.3 µg/L.
RW-28	09/30/88	11/18/91	6	Arsenic values ranged from 5.9 to 7 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-29	05/18/89	11/18/91	5	7/16/91. Manganese at 70 µg/L.
RW-30	09/30/88	09/30/88	1	
RW-31	09/30/88	05/11/95	13	7/16/91. Manganese at 190 µg/L
RW-32	09/30/88	05/11/95	13	Arsenic values ranged from non detected (<10 µg/L) to detection levels from 8.3 to 20 µg/L. Arsenic values appear to be consistently elevated above 5 µg/L.
RW-33	**03/03/88**	**05/01/90**	**3**	Iron was not sampled for prior to 9/25/89. On 9/25/89, iron was measured at 2460 mg/L and the subsequent sample on 5/1/90, iron was measured at 2430 mg/L. This well was not sampled after 5/1/90. Arsenic values ranged from 2.2 to 5 µg/L.

Appendix B. Summary of Residential Sampling Results. Samples were collected and analyzed by the Fulton County Hazardous Substance Committee (FCHSC) (Continued).

Well	Sampling Begin	Sampling End	Number of Samples	Comments*
RW-34				No data available to ATSDR.
RW-35				
RW-36				
RW-37				

* Comments are included when a chemical or element exceeds an EPA Maximum Contaminant Level (MCL). If an MCL is not available, ATSDR comparison values are used. Arsenic is reported if the measured value exceeds 5 µg/L.

** Wells with 0.25 miles of Four County Landfill are highlighted using bold print.

*** Wells that are hydraulically downgradient of the site are highlighted using italic print. Some wells are highlighted with both bold and italic print.

Appendix C. Residential Wells Sampled by IDEM on March 9, 1998 [5].

Well	Sample ID	Arsenic	Iron	Chloroform	Bromodichloromethane	Dibromochloromethane	Trichlorofluoromethane	1,4-Dichlorobenzene	Comments
Trip Blank	RI5333			61	8.6	1.0	ND	ND	
Trip Blank	RI5335			64	9.0	0.9	ND	ND	
No Number	RI5348	<4.0	<10	ND	ND	ND	ND	ND	
11	RI5364	<4.0	2600	ND	ND	ND	ND	ND	
6	RI5365	6.2	5800	ND	ND	ND	ND	ND	
5	Not Sampled			ND	ND	ND	ND	ND	Not able to sample because the water pipes were frozen.
32	RI5366	<4.0	6900	ND	ND	ND	ND	ND	
39	RI5367	<4.0	2200	ND	ND	ND	ND	ND	
36	RI5368	16.	2300	ND	ND	ND	ND	ND	
1	RI5337	9.2	3,100	ND	ND	ND	ND	ND	
2	RI5338 and duplicateRI5339	<4.0 <4.0	4000 4000	ND	ND	ND	ND	ND	
26	RI5340	21.	3600	ND	ND	ND	ND	ND	
3	RI5341	8.3	2300	ND	ND	ND	ND	0.9	MCL = 75 µg/L
8	RI5342	<4.0	3400	ND	ND	ND	ND	ND	
12	RI5343	8.5	5100	ND	ND	ND	0.5	ND	LTHA 2000 ppb
9	RI5344	<4.0	3100	ND	ND	ND	2.3	ND	

Volatile Organic Compounds consisted of 85 compounds analyzed by EPA Method 524.2 ("Methods for the Determination of Organic Compounds in Drinking Water", EPA/600/4-88/039)

Semivolatile Organic Compounds consisted of 63 compounds analyzed by EPA Methods 525.1 and 525.2.

Metals consisted of 13 elements analyzed by EPA Method 200 series. Only 8 elements, arsenic, barium, cadmium, chromium, lead, mercury, selenium, and silver were analyzed for in each sample. Copper, iron, manganese, nickel, and sodium were not routinely analyzed for in the samples.